

Ocean Energy Assessment

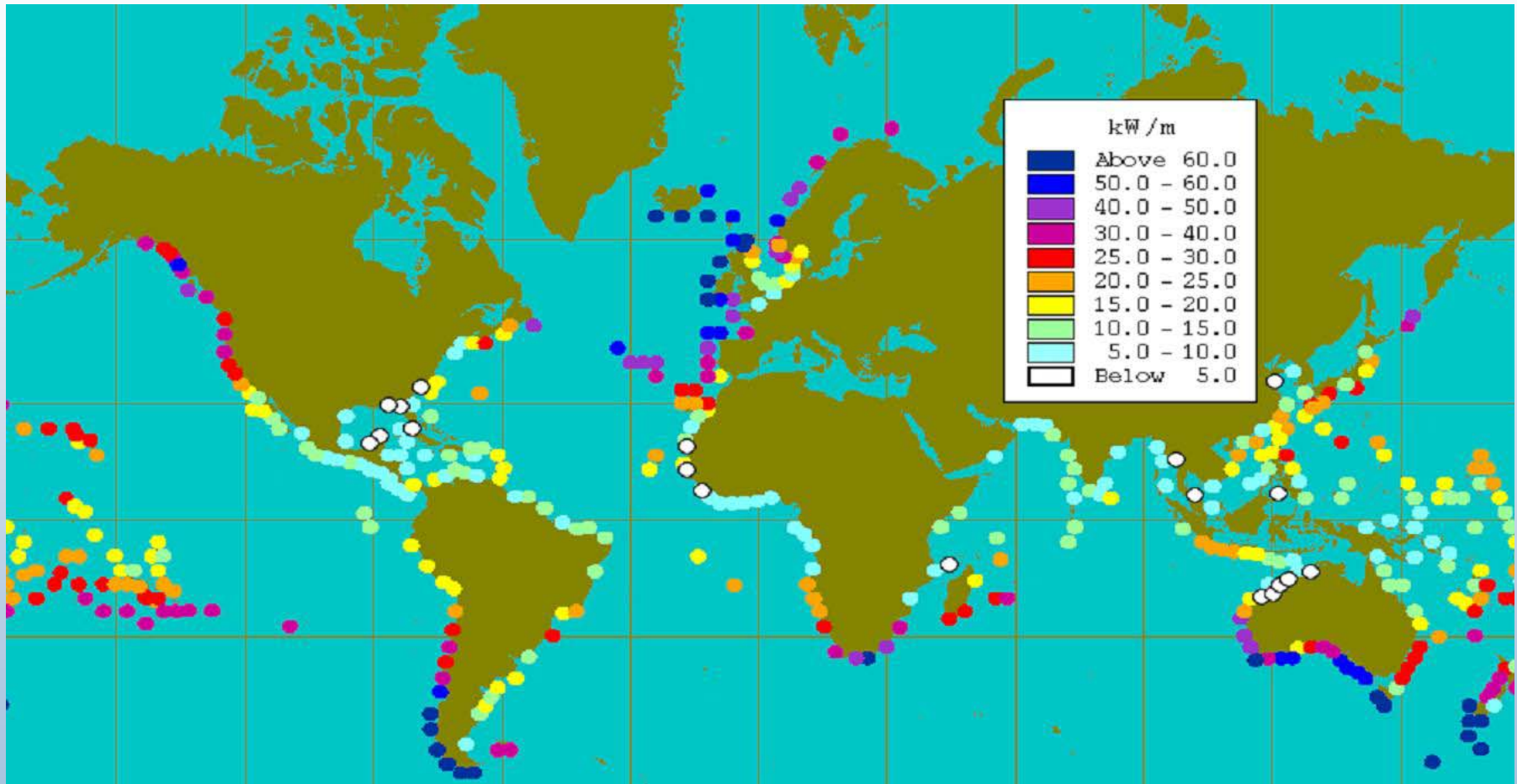
FY2005 Budget \$50k

- Wave
- Tidal (No impoundments)
- Current
- Not OTEC (Program Closed Out in 1990's)

Why this New Effort?

- Embryonic Technology shows promise to be cost competitive with sufficient R&D support
- US Companies developing new concepts under private funding experiencing development problems
- International and domestic interests mounting
 - UK has extensive public program
 - Created European Marine Energy Center, Orkney Island
- Consistent with National Energy Policy
 - Seek out cost effective, clean, domestic energy sources
- Diversifying domestic energy resources
- Increasing national security, energy independence

Global Wave Power Distribution



Current NREL Activities

- Assessing the potential resource
- Conducting a technology characterization
 - Determine what is technically and commercially feasible in collaboration with E2I/EPRI and six States
 - See www.e2i.org
 - Tracking domestic demonstrations
 - Rhode Island - Energetech
 - Hawaii – Installed, congressional appropriations
 - Washington state - AquaBUoy

Current NREL Activities

- Analyzing permitting requirements
 - FERC lead permitting agency for wave projects
 - First jurisdictional case with AquaEnergy
<http://www.his.com/~israel/loce/fercdec.pdf>
 - Multiple agencies involved, e.g., US Army Corp of Engineers, State coastal zone management agencies
 - Barrier to timely demonstrations
 - Other permitting requirements for current and tidal projects not explored

FY2005 Activities

- The Department of Energy/NREL evaluates the status and viability of ocean renewable technologies in the near term and longer term (20 timeframe)
- Identifies knowledge gaps and R&D issues
- Evaluate the Scottish test site model for the US
 - European Marine Energy Centre – Orkney
 - One site - 4 berths connected by subsea cable
 - One stop shop permitting for testing and demonstrations
 - Integrated management System
 - Considers ecological effects, safety
- Develops an R&D Plan for Ocean Energy

Ocean Power Technologies

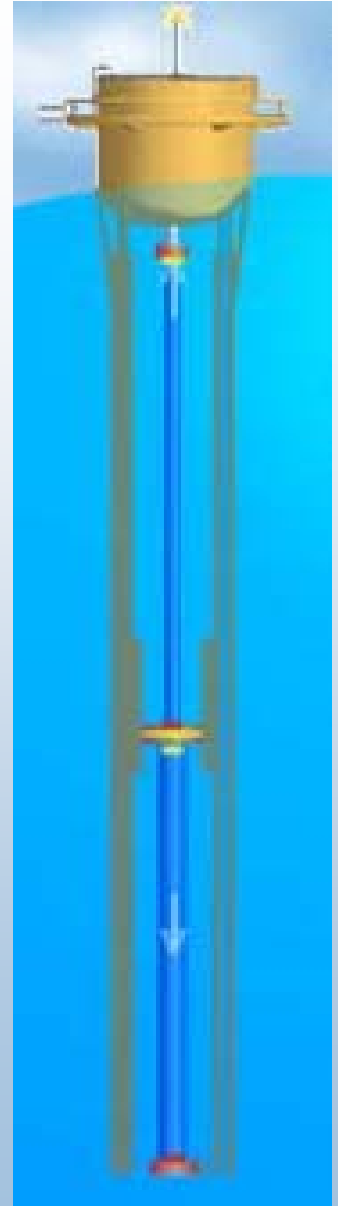
Kaneohe Bay, HI

- Six wave energy conversion buoys
- Marine Corps site = federal jurisdiction
- Congressional appropriations
- EA published January 2003
 - **Prepared by the Navy**
 - **300 pages**
- Applied for the USACOE Section 10 permit
 - **Application filed with the EA**
 - **Received “letter of permission” - covered buoys and the cable**
 - **Special Condition - Prepare an invasive species plan before construction**



AquaEnergy Group Ltd

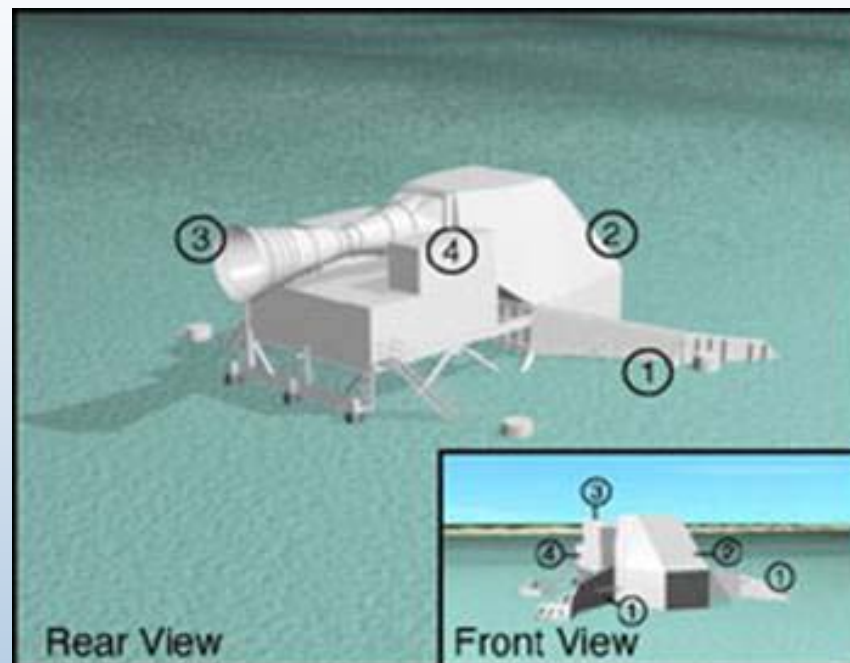
- AquaBuOY freely floating heaving point absorber
 - 6m buoy diameter
 - Array of 4 Buoys producing 1MW (625 X 450 feet)
 - 3.2 nm from shore
- April 2002 submitted preliminary state applications
 - Received “temporary permits” for marine research in Makah Bay (Sept. 2002-March 2003)
- FERC court appeal (February 2003)
 - Filed request to use the ALP (July 2003)
 - Communications protocol
 - Request approved (Sept 2003)
- Expecting to be operational by 2006



Energetech America

GreenWave Rhode Island

- Located near Port Judith Point, RI
- Oscillating water column –
 - Four-legged structure, resting on small pads
 - Mooring lines, parabolic wall (35m width)
 - 100X 120 (40 feet above the water)



Marine Current Turbines, Ltd. – Pilot Project



300 kW pilot turbine
installed summer of
2003, off Cornwall in the
English Channel

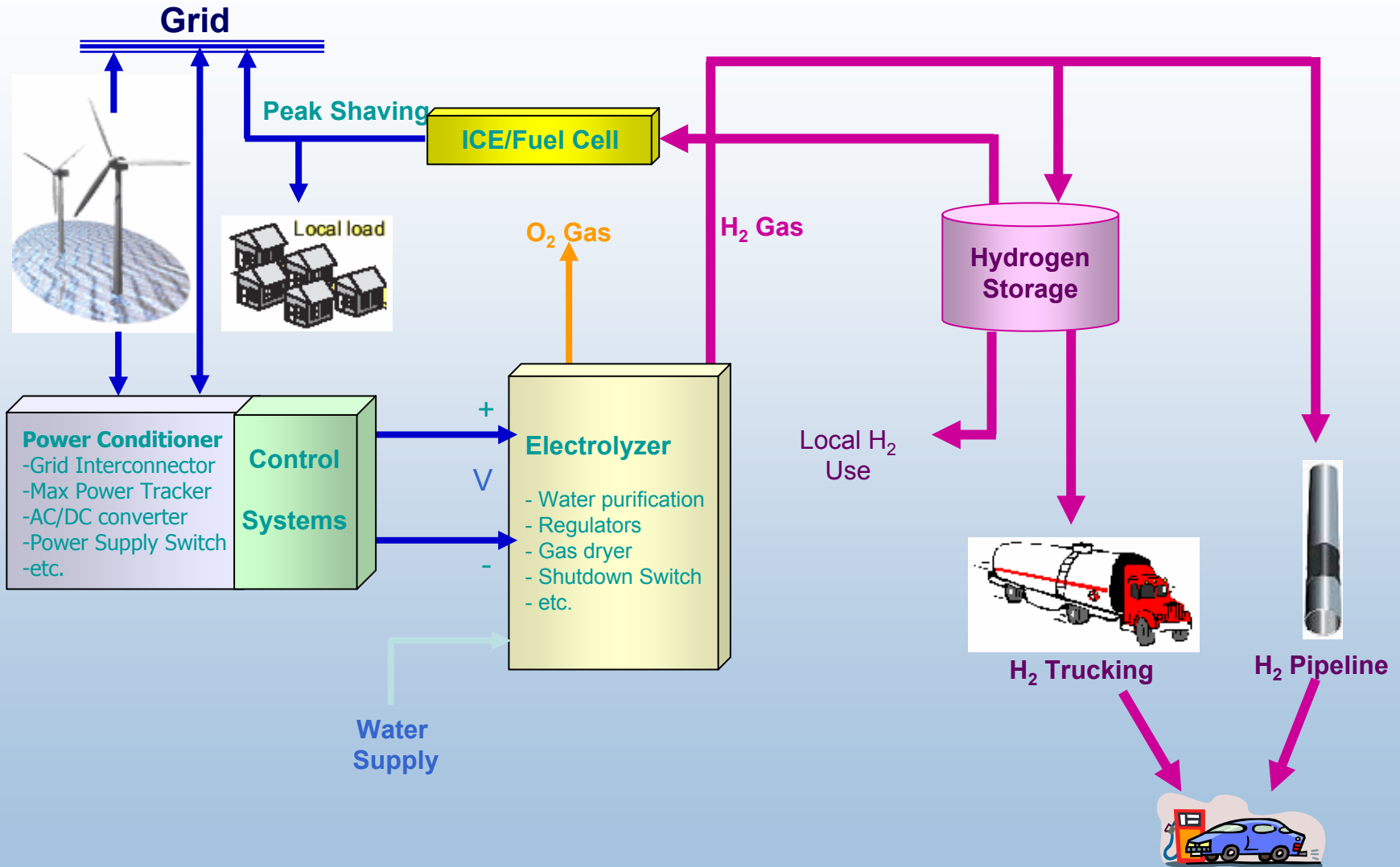


EMEC

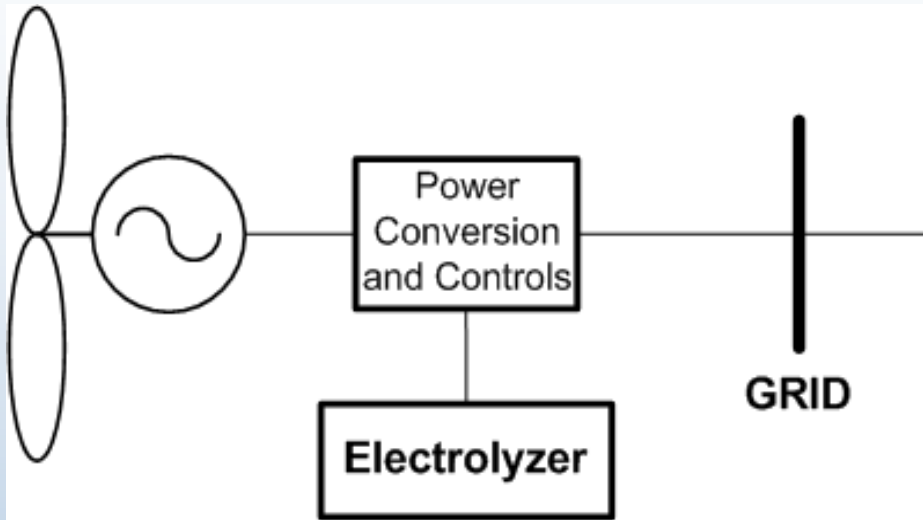
ORKNEY



Overall Wind-Hydrogen System Concept



Wind - Electrolysis System Under Study at NWTC



Tightly-Coupled Grid Parallel

- ✓ May operate if grid lost
- ✓ Shares controls and power conversion
- ✓ Electrolyze using wind turbine OR grid power
- ✓ Can reduce electrolyzer power fluctuations
- ✗ Restricted to location near turbine
- ✗ Complicated hydrogen collection

Wind - Hydrogen R&D

FY2005 Budget: \$103k

- The Hydrogen R&D is done in collaboration with the DOE Hydrogen Program, and NREL's Electric & Hydrogen Technologies & Systems Center
- The University of North Dakota (UND) is also collaborating with NREL using DOE funding through an EPSCoR Grant and NREL's experimental facilities
- Kevin Harrison a UND PhD student has characterized a 5kW PEM electrolyzer and is designing a Power Electronics Interface to control the and optimize the electrolyzer output for wind applications as his PhD Thesis
- NWTC staff are providing testing and instrumentation support and limited analysis of wind – hydrogen system configurations.

Supporting Environmental R&D

FY 2005 Budget: \$370k

Activities:

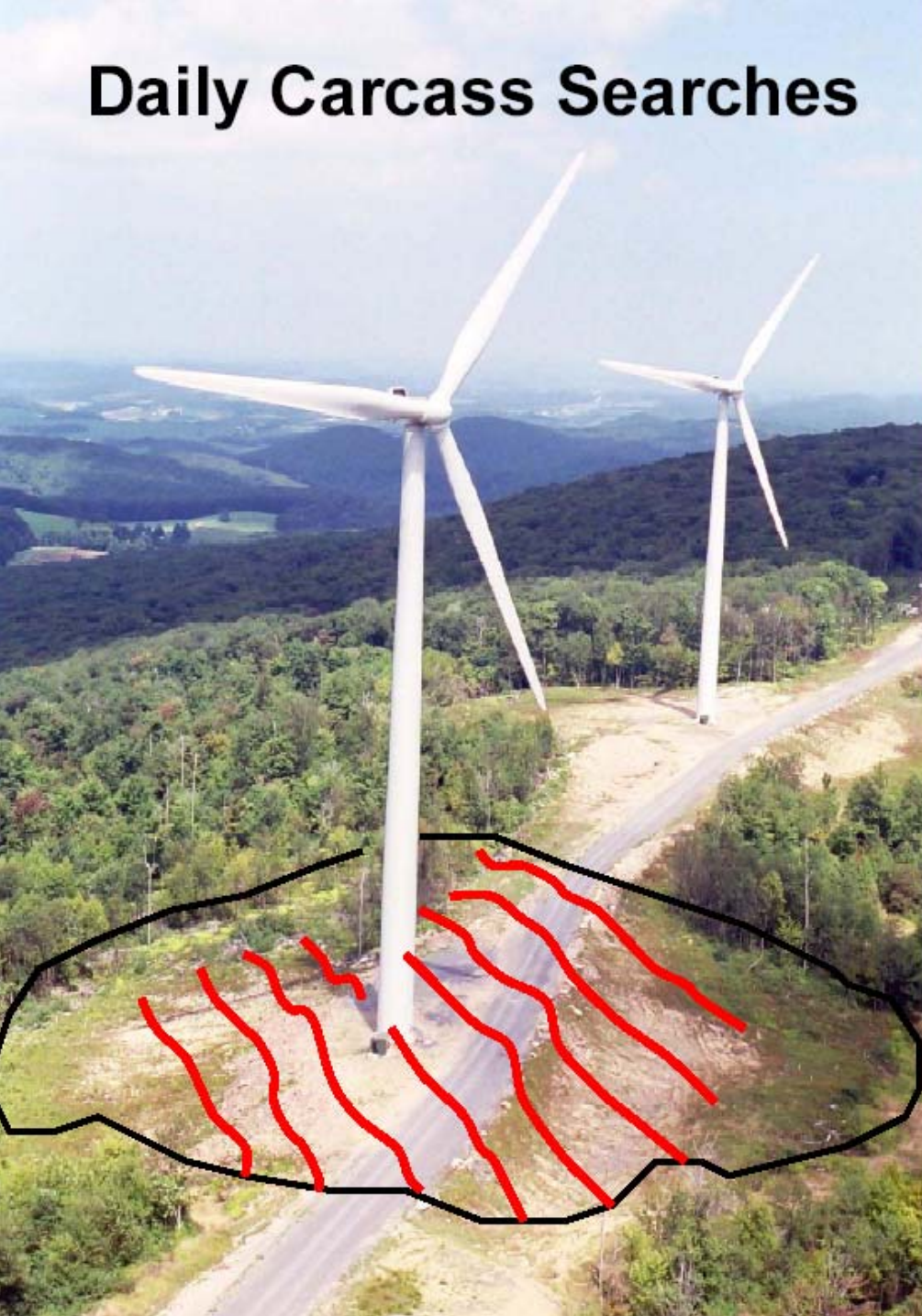
- Member of the Bats & Wind Energy Cooperative providing \$60k/yr and related technical support.
- NWCC technical and strategic & technical support for the Wildlife working group activities at about \$250k/yr
- NREL Internal technical support for review, presentations and assessment of the current state of knowledge about wind facilities and wildlife impacts at a level of effort of \$60k/yr. Examples include:
 - Supporting the BLM PEIS (Draft currently released for public comment)
 - Participation in the NWCC Wildlife Working Group Activities
 - Providing wind technical support to USFWS for seminars & training activities
 - Maintaining a literature data base on wildlife and wind energy interactions
 - Supporting State and local organizations in the review of guidelines and wildlife interaction assessments

Bats and Wind Energy Cooperative



Source: Ed Barnett, BCI

Daily Carcass Searches



Source: Ed Barnett, BCI

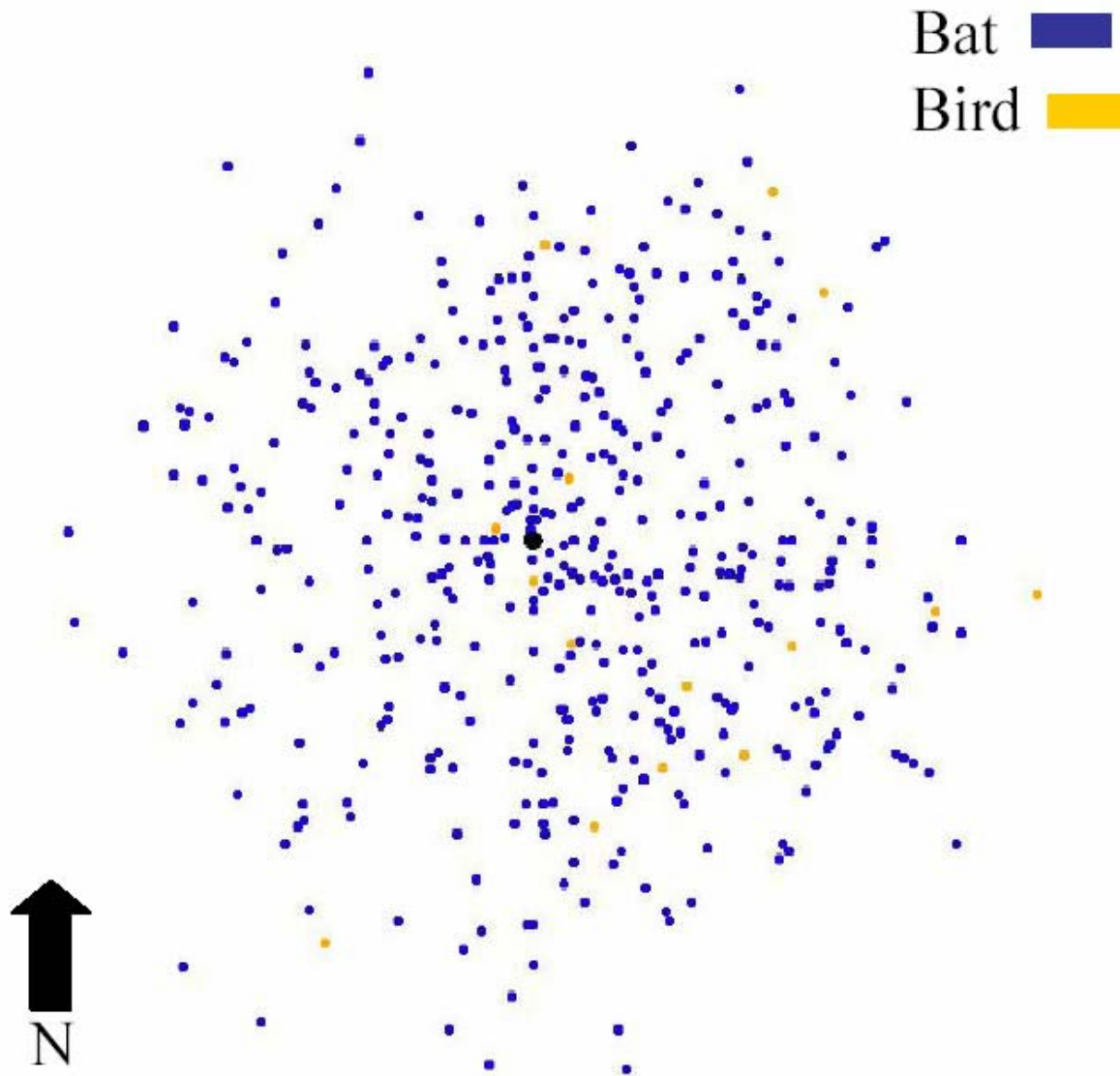
Bat Fatality Studies in the U.S.

| Region | No. studies | #MW | #/turbine/ #/MW/yr | ~ Total Mortality |
|-----------------|-------------|-----|-----------------------|-------------------|
| Northwest | 4 | 397 | 1.2/1.7 | 675 |
| Rocky Mountains | 2 | 68 | 1.2/1.9 | 129 |
| Upper Midwest | 4 | 254 | 1.7/2.7 | 686 |
| East | 2 | 68 | 46.3/32.0 | 2176 |

- Most estimates adjusted based on searcher efficiency and carcass removal from birds

Source: Greg Johnson, WEST, Inc.

Distribution of Fatalities

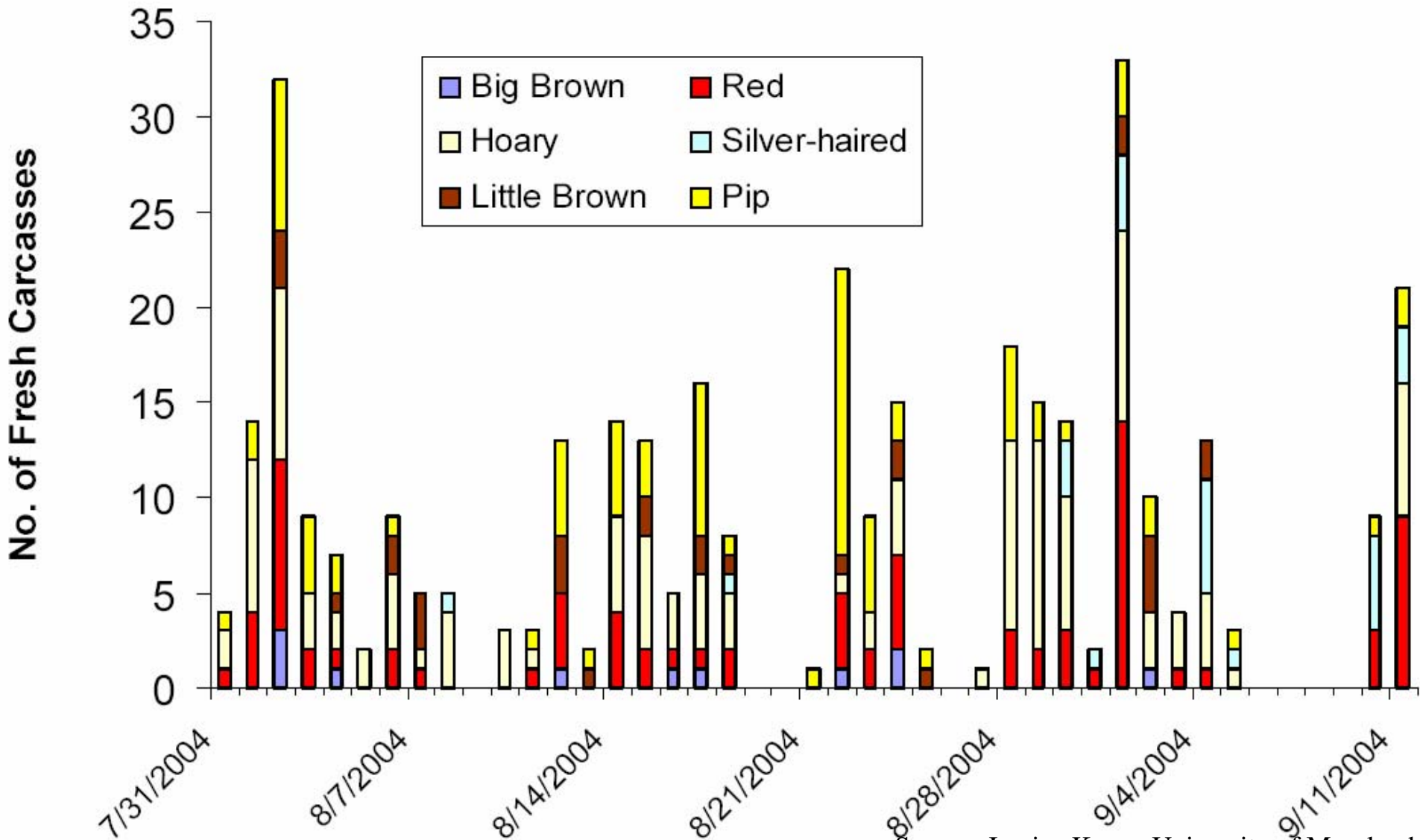


| Quad | % Bat Fatalities |
|------|------------------|
| NE | 26.6% |
| SE | 32.6% |
| SW | 18.9% |
| NW | 21.9% |

| Distance (m) | % Bat Fatalities |
|--------------|------------------|
| 0-10 | 15% |
| 11-20 | 25.7% |
| 21-30 | 30.3% |
| 31-40 | 22.1% |
| 41-50 | 5.4% |
| >50 | 1.5% |

Source: Jessica Kerns, University of Maryland

Fresh Bat Fatalities by Species



Source: Jessica Kerns, University of Maryland

Bats and wind turbines: infrared analysis of abundance, flight patterns and avoidance behavior

Jason Horn, Ed Arnett, Rodrillio Rodriguez
Boston University and Bat Conservation International

Altamont Pass Mortality Estimates

Annual mortality estimates for raptors (and all birds combined) across the entire APWRA.

These estimates are the sums of projections among three sets of wind turbines, where each projection is specific to the associated set of wind turbines.

For each species, the projection for the 1,536 wind turbines in Set 1 (1998-02) was added to that of the 2,538 wind turbines in Set 2 (2002-03) and to that of the 1,326 turbines of Set 3 (unsurveyed).

We regard the mortality estimates in the left and right columns as the low and high values of the uncertainty range for each species.

| Species/Taxonomic Group | Annual Mortality Estimates | |
|--------------------------------|-------------------------------|--|
| | Adjusted for search detection | Adjusted for search detection and scavenging |
| Golden Eagle | 75.6 | 116.5 |
| Turkey Vulture | 2.4 | 2.9 |
| Red-tailed Hawk | 208.9 | 300.4 |
| Ferruginous Hawk | 15.2 | 24.1 |
| Northern Harrier | 0.9 | 1.1 |
| Prairie Falcon | 1.7 | 2.1 |
| American Kestrel | 73.3 | 333.1 |
| Burrowing Owl | 98.8 | 380.2 |
| Great Horned Owl | 7.8 | 10.1 |
| Barn Owl | 35.6 | 49.0 |
| All raptors¹ | 881.4 | 1300.3 |
| All birds² | 1766.5 | 4721.3 |

¹ estimates include unidentified raptors

² represents raptors + non-raptors; estimates include unidentified birds

Source: Linda Spiegel, CEC

Information Review - Habitat Impacts of Wind Power on Sage Grouse

NWCC Research Meeting V
November 3-4, 2004, Lansdowne, VA



Lynn Sharp



TETRA TECH FW, INC.

Source: Lynn Sharp, TetraTech, Inc.

Peregrine Falcons

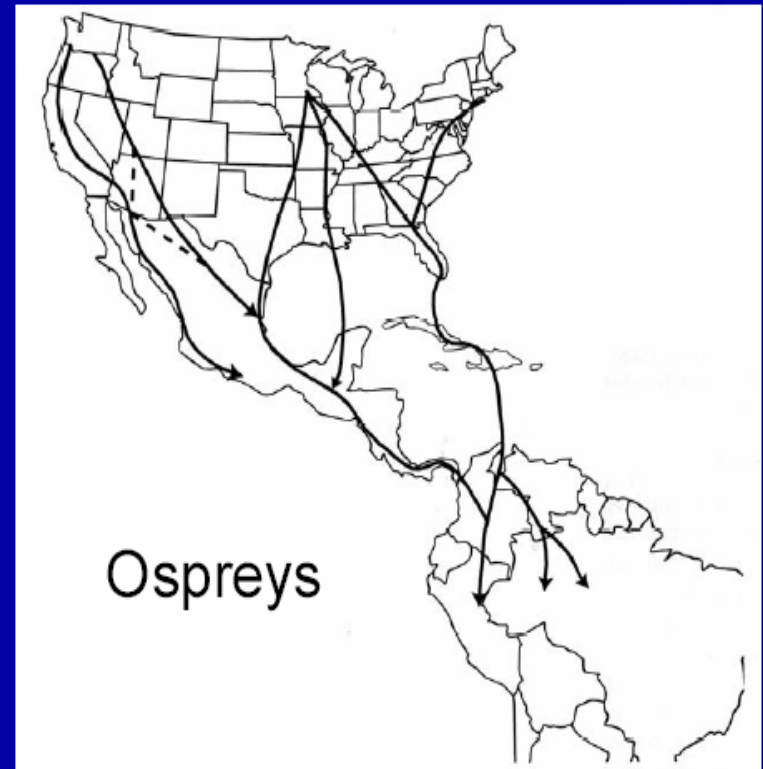


Fuller et al. 1998 J. Avian Biology

Swainson's Hawks



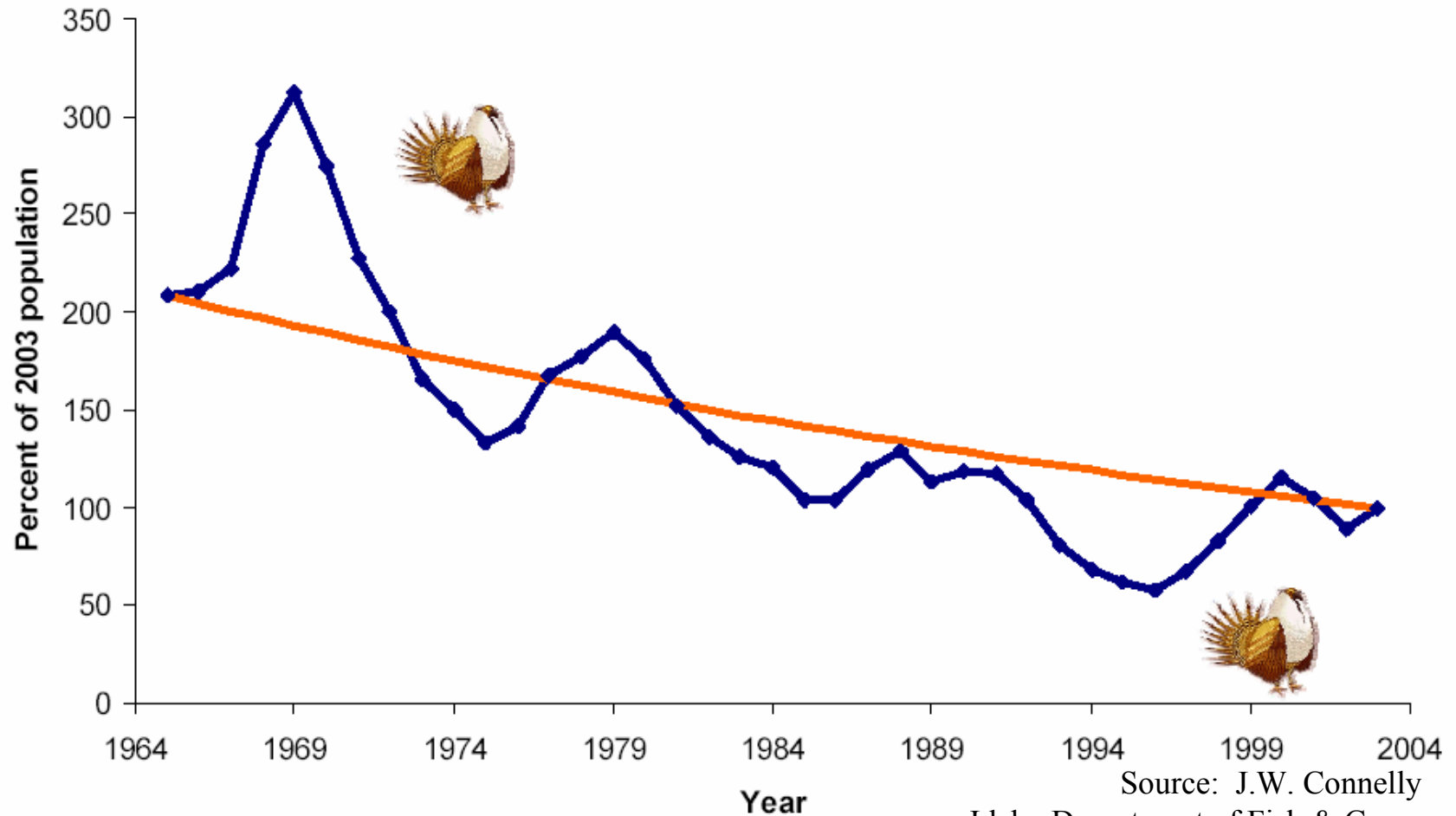
Satellite Tracking of Migration Routes



Martell et al. 2001 Condor

Source: Jeff Smith, HawkWatch, International

Greater Sage-Grouse Trends



Source: J.W. Connelly
Idaho Department of Fish & Game